

## CHAPTER 3

# EXACT SCIENCE AND THE URBAN REVOLUTION

### 1. PRELIMINARY REMARKS

It is perhaps expected that we should now pass on straight-way to the account of the two urbanizations—and also of the period intervening between the two—and take up the question of science and technology in these periods. However, it may be a methodological advantage if we begin with some preliminary clarification of the general question concerning the relation between urbanization and the making of exact science.

We have already had some words on the relation between technology and science and we have referred to the view according to which any attempt to try to understand science without its relation to technology is liable to be arbitrary. Following this understanding, Farrington quotes J. G. Crowther, who describes science as “the system of behaviour by which man acquires mastery of his environment”.<sup>1</sup> Farrington makes this the basis of his extremely meaningful survey of *Greek Science*, inclusive of the tendency of some of the later Greek philosophers to view science as a purely disinterested search for Truth. As he<sup>2</sup> briefly puts it :

Science whatever be its ultimate developments, has its origin in techniques, in arts and crafts, in the various activities by which man keeps body and soul together. Science arises in contact with things, it is dependent on the evidence of the senses, and however far it seems to move from them, must always come back to them. It requires logic and the elaboration of theory, but its strict logic and choicest theory must be proved in practice. Science in the practical sense is the necessary basis for abstract and speculative science.

There is thus an obvious advantage in viewing science as a system of behaviour by which man acquires mastery of his environment. Taken in an absolute sense, however, it has the risk of making the denotation of science too wide, inasmuch as it makes the emergence of science coextensive with that

1. Farrington GS 18.

2. *Ibid.*

of man as a tool-making animal. Not that there is nothing in such a view. As Gordon Childe<sup>3</sup> says :

Even the simplest tool made out of a broken bough or a chipped stone is the fruit of long experience—of trials and errors, impressions noticed, remembered and compared. It may seem an exaggeration, but it is yet true to say that any tool is an embodiment of *science*. For it is a practical application of remembered, compared, and collected experiences of the same kind as are systematized and summarized in scientific formulas, descriptions and prescriptions.

Notwithstanding what is evidently true in this, the fact remains that, ordinarily at any rate, when we speak of science we do not use the word in so wide a sense. In Gordon Childe's own masterly survey of global archaeology, it was only after the prolonged accumulation of quantitative changes in the technological accomplishments of man that a stage is reached when a qualitative leap is taken in man's ability to control and understand the world in which he lives. Hence is the need felt for a new terminology to refer to the new dimensions assumed basically by the same ability. The term Gordon Childe himself uses for it is "exact and predictive science." It knocks as it were for the gates to be first opened for the coming of what we are ordinarily accustomed to call 'science' today.

## 2. SCRIPT AND EXACT SCIENCE

The decisive invention that makes science in this sense possible is that of writing or of the script. In the pre-literate communities, the technological experience in which science is only implicit is transmitted as craftlore, in the form of oral precepts and examples. Such a mode of the transmission of knowledge is essentially imitative with little or no "opportunity of introducing a variation which might be beneficial".<sup>4</sup> Hence there is no scope for developing an understanding of how to do something in order to do it better.<sup>5</sup> Craftlore, in short, is circumscribed by severe conservatism, various aspects of which we shall later see.

With the invention of the script and the possibility of committing to writing in general terms the knowledge derived

3. Childe WHH 9.

4. *Ibid* 79.

5. Bernal SH 47.

through the interrogation of nature, the conservatism characteristic of craftlore is largely broken, and, along with it, many a fetter for technology to develop into science. The profound importance of the invention of writing for the historical development of science can hardly be exaggerated. This, as Gordon Childe observes, "was destined to revolutionize the transmission of human knowledge. By its means a man can immortalize his experience and transmit it directly to contemporaries living far off and to generations yet unborn. It is the first step to raising science above the limits of space and time."<sup>6</sup>

It remains for us to see, of course, if there is another side of this tremendous step forward in the development of knowledge. But let us not complicate our present discussion with such questions.

### 3. "THE URBAN REVOLUTION"

Our understanding of the invention of writing—and therefore also of the first formation of exact science as leaning on this—would be very inadequate if viewed without their appropriate socio-economic background. These are rather to be understood as features of a profoundly significant socio-economic transformation for which Gordon Childe uses the expression "the urban revolution."

In 1936, he formulates this concept in the book *Man Makes Himself*. In 1942, he reiterates his main points about it and carries forward the subsequent story of man upto the decline and fall of the ancient world in the book *What Happened in History*. In 1950, he sums up his main results in a brief article published with the title *The Urban Revolution*.<sup>7</sup>

In this article—surveying mainly the civilizations of the Old World, namely Egypt, Mesopotamia and India, and comparing these also with the Mayas of America—he formulates "ten rather abstract criteria, all deducible from the archaeologist's data" which "serve to distinguish even the earliest cities from any older or contemporary village."<sup>8</sup>

6. Childe MMH 186.

7. Childe 'The Urban Revolution' first published in *Town Planning Review*, Vol. 21 No. 1, 3-17. Liverpool Univ. Press. Reprinted in Possehl's ACI 12-17. Our references to the article are to the latter.

8. Childe 'The Urban Revolution' in Possehl's ACI 15.

This article has provoked a great deal of discussion among the archaeologists, sociologists and historians, though some of the critics of Gordon Childe appear to have overlooked his main thesis specially as worked out in his earlier books in greater details. In any case, as it is rightly observed, there is no better categorization of the urban traits than offered in this brief essay.<sup>9</sup> We may conveniently begin with it.

Here is how Gordon Childe<sup>10</sup> sums up the most essential point for understanding the urban revolution :

About 5000 years ago irrigation cultivation (combined with stock-breeding and fishing) in the valleys of the Nile, the Tigris-Euphrates and the Indus had begun to yield a social surplus, large enough to support a number of resident specialists who were themselves released from food-production. Water-transport, supplemented in Mesopotamia and the Indus Valley by wheeled vehicles and even in Egypt by packed animals, made it easy to gather food stuffs at a few centres. At the same time dependence on river water for the irrigation of the crops restricted the cultivable areas while the necessity of canalising the waters and protecting habitations against annual floods encouraged the aggregation of population. Thus arose the first cities—units of settlement ten times as great as any known neolithic village. It can be argued that *all cities in the old world are offshoots of those of Egypt, Mesopotamia and the Indus basin*. So the latter need not be taken into account if a minimum definition of civilization is to be inferred from a comparison of its independent manifestations.

Before any attempt is made at a critical evaluation of Gordon Childe's view, it is necessary to be clear about the view itself. Two points need to be specially noted in this connection. First, what he calls "the urban revolution" is not to be equated to any and every process of urbanization, revolutionary though such a process may be. In other words, what he is really discussing is the first momentous socio-economic transformation in human history that leads to the formation of the earliest cities. This takes place in the old world in three regions, namely Egypt, Mesopotamia and the Indus basin, which are accordingly viewed by him as the three "primary centers" of the urban revolution. From Gordon Childe's viewpoint, all

9. D.K. Chakrabarti, and A. Ghosh in *Puratattva* No. 6, 1972-73. 27, 34. See also, A. Ghosh in Possehl's HC p. 20ff.

10. Childe 'The Urban Revolution' in Possehl's ACI 14-15. Emphasis added.

the ten distinguishing features of the urban revolution are not to be sought in the later centres of urbanization, though all these later centres are historically indebted to the three primary centres of the urban revolution. This point is worked out at some length in the book *What Happened in History*,<sup>11</sup> though in the brief article on *The Urban Revolution* also, Gordon Childe wants to be very clear about it:<sup>12</sup>

.... all later civilizations in the Old World may in a sense be regarded as lineal descendants of those of Egypt, Mesopotamia or the Indus. But this was not a case of like producing like. The maritime civilizations of Bronze Age Crete or classical Greece for example, to say nothing of our own, differ more from their reputed ancestors than these did among themselves. But the urban revolutions that gave them birth did not start from scratch. They could and probably did draw upon the capital accumulated in the three allegedly primary centres. That is most obvious in the case of cultural capital. Even today we use the Egyptians' calendar and the Sumerians' divisions of the day and the hour. Our European ancestors did not have to invent for themselves these divisions of time nor repeat the observations on which they are based; they took over—and very slightly improved systems elaborated 5,000 years ago!

Secondly, the ten criteria mentioned by Gordon Childe for distinguishing the earliest cities from the neolithic villages are not to be understood as just a compilation or an inventory of certain empirically observed features of the urban centres. From his point of view, at any rate, these are rather internally related with each other, and hence no one of these is to be understood as detached from the rest. Adams<sup>13</sup> observes that these traits are but "loosely associated features", which is precisely what Gordon Childe does not intend his view to be understood. If, therefore, one or other of these traits is not palpable or obvious in the case of any of the three primary centres of the urban revolution, from Gordon Childe's viewpoint it would be worthwhile to seek for circumstantial evidences that may be pointers to it, instead of hastily concluding that in this particular centre such a trait is just missing.

11. Childe WHH Chap. vii. 130 ff.

12. Childe 'The Urban Revolution' in Possehl's ACI 17.

13. R.M. Adams 11.

With these two clarifications, let us proceed to understand his main criteria of the urban revolution. We shall begin with brief notes on the first few of these and then pass on to consider the traits that interest us most for our own discussion. Thus :

(1) The first cities are "more extensive and more densely populated than any previous settlements". (2) These accommodate—perhaps over and above a small minority who are still peasants—"classes who did not themselves procure their own food by agriculture, stock-breeding, fishing or collecting, full-time specialist craftsmen, transport workers, merchants, officials and priests"—all these supported by the surplus produced by the peasants living mainly in the dependent villages. (3) Each primary producer paid over the tiny surplus he could wring from the soil...as tithe or tax to an imaginary deity or a divine king who thus concentrated the surplus. (4) "Truly monumental public buildings" in the cities, symbolizing "the concentration of the social surplus." (5) Though in the cities all those not engaged in food-production were supported by the surplus accumulated in the temple or royal granaries, yet "naturally priests, civil and military leaders and officials absorbed a major share of the concentrated surplus", and thus formed the "ruling class", which "did confer substantial benefits upon their subjects in the way of planning and organisation." All this helps us to understand the sixth and seventh traits of the urban revolution which, because of their immediate relevance for our discussions, we quote<sup>14</sup> in full from his essay :

(6) They (the members of ruling classes) were in fact compelled to invent systems of recording and exact, but practically useful sciences. The mere administration of the vast revenues of a Sumerian temple or an Egyptian pharaoh by a perpetual corporation of priests or officials obliged its members to devise conventional methods of recording that should be intelligible to all their colleagues and successors, that is, to invent systems of writing and numeral notation. Writing is thus a significant, as well as a convenient, mark of civilization. But while writing is a trait common to Egypt, Mesopotamia, the Indus Valley and Central America, the characters themselves were different in each region and so were the normal writing materials.

14. Childe 'The Urban Revolution' in Possehl's ACI 16.

(7) The invention of writing—or shall we say the inventions of scripts—enabled the leisured clerks to proceed to the elaboration of exact and predictive sciences—arithmetic, geometry and astronomy. Obviously beneficial and explicitly attested by the Egyptian and Maya documents was the correct determination of the tropic year and the creation of a calendar. For it enabled the rulers to regulate successfully the cycle of agricultural operations. But once more the Egyptian, Maya and Babylonian calendars were as different as any systems based on a single natural unit could be. Calendrical and mathematical sciences are common features of the earliest civilizations and they too are corollaries of the archaeologists' criterion, writing.

#### 4. MATHEMATICS, ASTRONOMY AND THE URBAN REVOLUTION

We shall return later to discuss Gordon Childe's formulation of some other traits of the urban revolution. For the present let us have some clarifications about what is already quoted.

We propose specially to note three points in this connection.

First, the emergence of mathematics and astronomy as exact sciences is viewed here not as a mere concomitance of the urban revolution. It is understood, on the contrary, as an essential feature of a highly complex and profoundly significant socio-economic transformation, which Gordon Childe has been discussing. As he puts it elsewhere, "The synchronism is not accidental. The practical needs of the new economy had, in fact, evoked the innovations."<sup>15</sup>

Secondly, while discussing the first creation of exact and predictive sciences, Gordon Childe mentions only mathematics (arithmetic and geometry) and astronomy (inclusive of the calendrical science). He does not mention natural sciences well-known to us in other forms, like chemistry and physics, botany and zoology—and not even any system of rationalist medicine. Evidently, there is no evidence for the making of these natural sciences in the earliest centres of civilization. This is quite striking, because the *potentials* of these must have been there in the spectacular technological achievements presupposed by the urban revolution. "Between 6000 and 3000 B.C.", as he says, "man has learnt to harness the force of oxen and of winds, he invents the plough, the wheeled cart

and the sailing boat, he discovers the chemical processes involved in smelting copper ores and the physical properties of metals, and he begins to work out an accurate solar calendar. . . . In no period of history till the days of Galileo was progress in knowledge so rapid or far-reaching discoveries so frequent".<sup>15</sup> However, when it came to the question of processing this knowledge and of giving it the form of exact science, steps were taken for the creation of mathematics and astronomy, and not the physical and biological sciences so familiar to us. The techniques in which the potentials of these natural sciences are implicit continued to be transmitted in the form of oral precepts and examples, allowing knowledge in other forms to be committed to writing as exact sciences. Apparently, there was something about the urban revolution that required the making of mathematics and astronomy as apparently again there was also something about the profound socio-economic transformation that discouraged the creation of natural sciences in other forms. We shall see how Gordon Childe wants us to understand this when we return to discuss his tenth trait of the urban revolution—a theme discussed by him in fuller details in the last two chapters of his *Man Makes Himself*.

Thirdly, his view of the urban revolution is based on a review of mainly three primary centres of the earliest civilizations in the Old World, namely Mesopotamia, Egypt and India. But his observation just quoted about the emergence of exact science is silent about India, notwithstanding his assertion that from the standpoint of technological accomplishments the Indian centre was "the peer of the rest". Could it, then, be that in spite of the splendid technological achievements, there was no step taken in the ancient Indus civilization towards the creation of mathematics and astronomy? This would certainly be farthest from his understanding. The ten traits of the urban revolution are for him not a mere jumble of loosely connected or unconnected features empirically observed in the earliest civilizations; these are—though discernible—rather internally related traits in terms of which it may be convenient for us to understand the momentous step taken by man towards civilization. The making of mathematics and astronomy being one of these traits is only to be expected also in the



Indus civilization. As a matter of fact, as we have already seen, Gordon Childe, in his book *What Happened in History*, proposes to seek the roots of classical Indian science in the achievements of the Indus civilization.

However, the difficulties about a straight-forward assertion of this are well-known. We have nothing of the nature of a direct document to prove mathematics and astronomy in the Indus period. The Indus civilization is equipped with the technique of writing no doubt. But, in spite of there being a rather imposing literature on the Indus script,<sup>17</sup> the fact is that it still remains undeciphered. It is even argued that the script "is virtually undecipherable".<sup>18</sup> Even admitting the possibility of it being deciphered in the future, there is really little or no hope of the Indus inscriptions—the total number of which so far known is in the region of 2,500<sup>19</sup>—throwing light on the scientific activities of the time, though there are some recent efforts to reconstruct from these elements of astronomical and calendrical knowledge.<sup>20</sup> These inscriptions are usually found on what are called the "seals", and a few also on the reverse side of small flat copper tablets. But the archaeologists are yet to be exact about what these "seals" were really meant for. "Though all these objects have been classed as seals, there is no evidence of their having been used to seal anything, whereas in Mesopotamia and Egypt sealings are far commoner than seals... The term 'seal' is therefore conventional, and the objects thus denoted must be classed as ritual—a learned way of saying that we have no notion what they were for".<sup>21</sup>

17. We may have some idea of this from the references given by Asko Parpola in EIP 180-186.

18. Arlene R.K. Zide, in Possehl's ACI 259.

19. B. & R. Allchin. RCIP 212. Mahadevan IS 6 catalogues 2906 legible inscriptions.

20. Asko Parpola in EIP 179. cf. also Bongard Levin, *The Image of India* 190 ff and Bongard-Levin in SUSSR 1981. 71 ff. However, as we shall later see, it seems to be premature to be exact about the value of such a claim.

21. Childe NLMAE 182. But it is recently claimed by some Indian archaeologists that there are evidences of these being actually used for sealing purposes. S.R. Rao LIC 119, e.g., asserts: "Lothal has the unique distinction of proving conclusively that

In any case, there is no ground to imagine that the inscriptions on the seals were intended to document scientific activities, beyond perhaps what is implied by the bare use of certain signs often viewed as numerals. The inscriptions are in fact too brief—consisting of five or six signs on an average—to suggest such documentation in spite of the increasing importance being attached to the hypothesis of these inscriptions embodying some calendrical information.

Thus, in short, we have nothing among the archaeological relics of the Indus civilization directly documenting the making of mathematics and astronomy as exact sciences. We have nothing comparable to the Egyptian papyri or Mesopotamian clay tablets witnessing to the same in the other two primary centres of the urban revolution. Of course, the possibility of there having been documents written on unknown but perishable materials cannot be absolutely ruled out, particularly because it is *prima facie* difficult to imagine that the script was invented by the makers of the Indus civilization only for the purpose of using these on the 'seals' on which these survive. But it is somewhat precarious to build up any dependable hypothesis mainly on the strength of the unknown, though from the presumption that the seal-cutters were themselves not the scribes, the use of perishable materials originally used by the scribes cannot be easily dismissed.

At the same time, as we are going to argue, there are indirect or circumstantial evidences justifying Gordon Childe's presumption of classical Indian mathematics and astronomy having roots in the ancient Harappan achievements.

the Indus seals were used for a commercial purpose and not as amulates or ornaments". The question, still appears to remain an open one.